2004 PROGRESS REPORT
Riparian Willow Restoration along the Illinois River at Arapaho NWR, Colorado

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BACKGROUND

Riparian willow communities along the Illinois River at Arapaho NWR provide important habitat for a number of wildlife species, including neotropical migratory birds. Existing stands are sparse and discontinuous throughout much of the Refuge and appear overaged, with little natural regeneration. Likely causes include historical clearing; reduced streamflow from water diversion; channel incision perhaps related to diminished sediment supply; possible climatic shifts; and high levels of herbivory from cattle, introduced moose, and elk which have recently increased densities and altered distributions.

The overall goal of this study is to inform restoration activities at Arapaho NWR by quantifying the effects of alternative management actions on riparian willow communities in order to provide the Refuge with a set of management tools with known effectiveness under different circumstances. There are three major components:

(1) A **core exclosure experiment** focused on herbivory release of willows with moisture (depth to water) as a co-variate;
(2) A series of **restoration tests** aimed at identifying efficient restoration procedures and identifying constraints on successful restoration; and
(3) **Contextual analyses** aimed at understanding the status and dynamics of willow in the valley as a whole and how the Refuge willow communities fit into a larger picture.

In 2003, the exclosures were constructed (Fig. 1) at five sites, a set of five wells were installed at each site, and an initial census and measurement of willows at exclosures and paired control plots was conducted. In 2004, we installed staff gages and stream water level recorders at each site (exclosure-control pair); conducted regular measurements of water level in the wells at each site, maintained exclosures; began topographic surveying to develop digital terrain models of each site; and conducted a set of experimental plantings in the spring.

2004 SUMMARY

CORE EXCLOSURE EXPERIMENT

We installed staff gages and have been recording water level at the staff gages and wells (5/site) at roughly two week intervals from May, 2004 to present. We anticipate intervals of 4-6 weeks during the winter. We also installed continuous (every 30 minutes) level recorders in one stream stilling well at each of the sites to track surface water changes.

We began, but have not completed, surveying to develop a digital terrain model (topographic map) of each of the sites. This will allow us to array plant responses in different zones and plots along a hydrologic gradient produced by combining ground elevations with water elevations.

RESTORATION TESTS

We began the anticipated series of annual restoration manipulations in 2004. This is a test at several levels involving specific, replicated experiments and also trying different equipment and administrative arrangements that might be employed in broader scale restoration.

Equipment and volunteers. We established a three-way Memorandum of Understanding and cooperative relationship among USGS, FWS, and Wildlands Restoration Volunteers (WRV), a non-profit organization based in Boulder, CO, that organizes group restoration activities using volunteers. WRV provided over 40 volunteers for the main planting weekend in late May, harvesting freshly cut poles and doing the planting in both the quantitative experiment described below and in a general "production" area trying a variety of planting procedures (poles in excavated holes, willow stakes driven into the channel bed and bank, and mats of willow cuttings). Qualitative results from this area included (a) pole-planting responses similar to those of the quantitative experiment described below; (b) little initial growth from the "bio-mat" of willow ; (c) and reasonable success from the quickly impolemented, bank-driven stakes.

The volunteer arrangement worked well, especially for those aspects of the overall job that are labor-intensive and do not require a sequence of actions over multiple days or weeks. There are some administrative costs associated with organizing and supporting this number of people and some potential timing constraints, especially in the case of inclement weather. Nonetheless, integral use of volunteers over multiple years may be the most feasible way of accomplishing widespread alteration of riparian vegetation at Arapaho, given budget realities.

We utilized a rented, tracked Bobcat (T190) with 6" auger to excavate holes. This worked well – on the order of 25 holes/hour once at a site. We were able to get close (road) to the sites with a trailer towed by a heavy-duty pickup. The tracked Bobcat was very maneuverable and produced very little "trail" impact because of the rubber tracks – this is the style of vehicle used for much golf course work. We had few problems with either caving of wet or unconsolidated hole walls or with hanging up cobbles between the auger blades. There may be lower cost alternatives such as a "stinger" or metal drive post attached directly to a front-loader. Also, conditions were relatively dry – it is unlikely that anything would work well if the valley bottom as a whole was very wet or under water.

Quantitative experiments. The quantitative experiment used *Salix lasiandra* (whiplash willow) pole cuttings. *S. lasiandra* is the largest of the common willows at Arapaho NWR. One quarter of each plot (both exclosure and control) at each of the 5 sites was used for the manipulations. Each manipulation subplot was divided into 3 zones of terrace or upland; near-bank (within 10 meters of bank-full lip); and channel (below bank-full lip) (Fig. 2). Two types of *S. lasiandra* poles were used as a species treatment: (a) fresh-cut in late-May at the time of planting about 2 weeks after bud-break; and (b) pre-cut about 2 weeks before bud-break. The pre-cut poles were stored at a State Forest facility in the mountains in a snowbank. Five replicates of each type of pole were placed in 1-m holes excavated with tracked-Bobcat mounted auger in the terrace and near-bank zones. In the channel zone, five bundles of each type of willow poles (3 poles/bundle) were staked in vertical trenches dug into the side of the bank.

Quantitative sampling for success of these plantings will take place during the next (2005) growing season. Qualitatively almost all planted material vigorously leaved out within the first month. There was substantial die-back in the drier August period. Die back was generally related to moisture gradient being highest in the drier (upland) zones of the drier (downstream) sites. Survivorship after leave out next spring will be a more meaningful measure of "success."

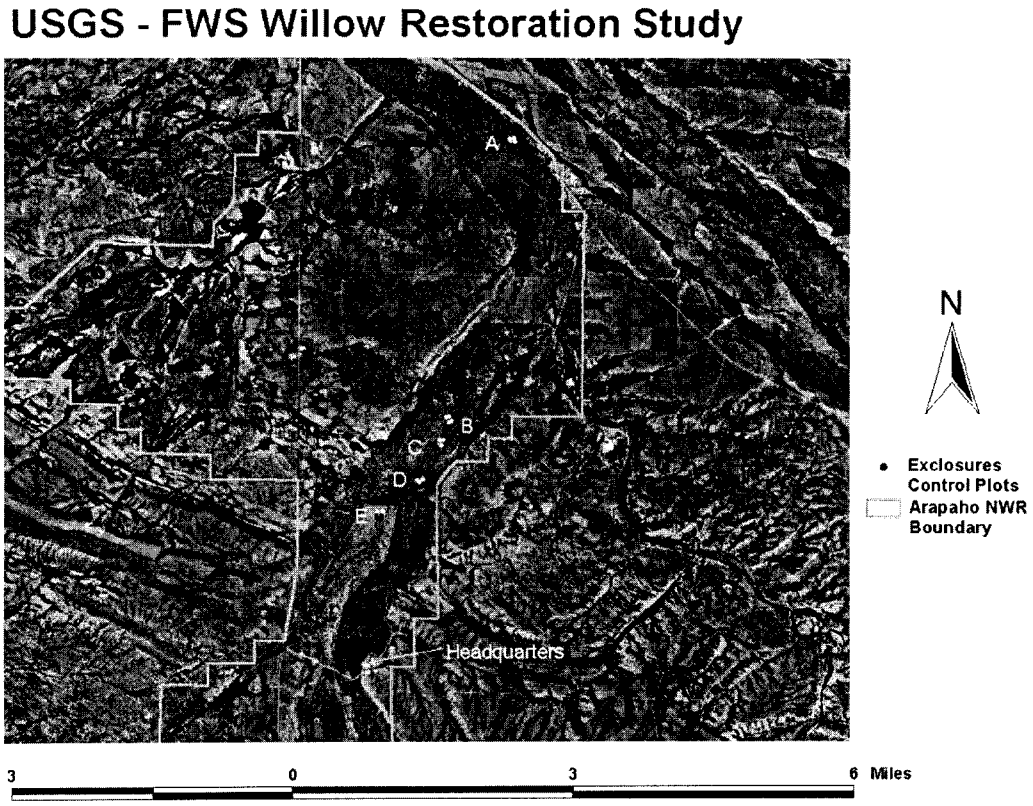

Figure 1. Location of study sites along Illinois River in northern portion of Arapaho NWR.

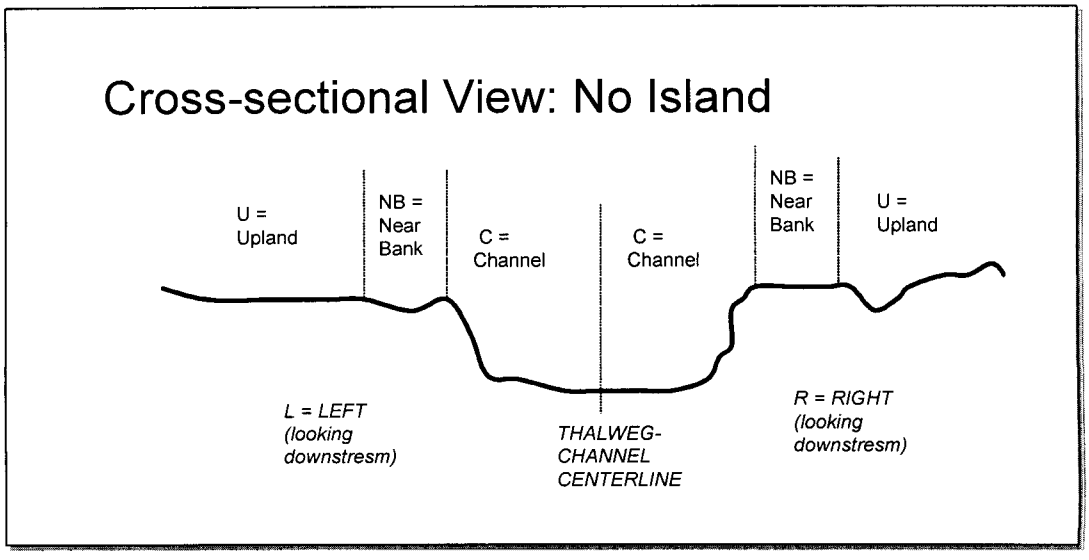

Figure 2. Cross-sectional view of sampling zones.

CONTEXTUAL ANALYSES

Again in 2004, we minimized work in this area to concentrate on getting started on those long-term study elements that will take years to see meaningful responses.

FUTURE PLANS

Having established replicated, controlled exclosures and initiated a series of experimental plantings, we are interested in continuing to measure responses on the time scale at which they will be ecologically meaningful and in collaborating with the Refuge in a process of iterative, adaptive restoration activity. In 2004, we were able to restructure the study with no net change in funding level from 2 more years to 4 more years at ½ the annual cost.

CORE EXCLOSURE EXPERIMENT

Approach. We do not anticipate a rapid, significant response and envision this as a long-term, 10-30 year demonstration of herbivory effects.

2005 Tasks.

(1) Continue to monitor water levels in stream and wells.
(2) Complete topographic surveys of the sites and wells, and develop elevation models of channel and near channel floodplain/terrace topography.
(3) Verify difficult taxonomic calls when flowering structures are present.
(4) Re-measure willows at end of growing season (conditional on magnitude of response).

RESTORATION TESTS

Rather than one complex factorial experiment or a single, large-scale production restoration, our approach is to conduct a series of smaller tests and comparisons. This will allow us to adaptively identify a suite of effective restoration procedures and isolate the factors limiting regeneration. This will hopefully provide management with a set of reliable options that could be scaled up for more extensive restoration over time. We will quantify success of the 2004 plantings by resampling near the end of the 2005 growing season (survival and growth). We have had several coordination meetings regarding experiments to be conducted in 2004. Final decisions are somewhat contingent on the funding of pending proposals that would fund continued volunteer involvement by WRV. We will probably not utilize the exclosure-control plot area in 2005 to avoid confounding the basic study of natural response to herbivory release. Options we are considering are:

1. *Unexclosed species mix plantings.* These would involve pole planning in the near bank or upland zones and probably driven stakes in the channel zone. We have pre-marked individuals of *S. lasiandra*, *S. geyeriana*, and *S. exigua* and are considering planting 3-stem bundles (one stem of each species) in each hole. S. exigua is not that common at the elevations of Arapaho NWR, but is interesting because of its relatively strong propensity for vegetative spread.
2. *Low-cost exclosures.* A 4-strand barbed wire, T-post fence appears to have been relatively effective in protecting a homestead-origin stand of narrow-leaved cottonwood (*P. angustifolia*) at the northern end of the Refuge. This suggests that small areas of low-cost fence might sufficiently discourage elk and cattle, even though the fence was not sturdy enough to guarantee exclosure. We would

construct several small patches of low-cost fence on depressions on the broad terrace zone and pole plant or drive stakes of willow. If successful, this type of low-cost, temporary fencing might be used for 3-5 years and then dismantled allowing large areas to be restored over time without permanent and expensive fencing. A semi-natural configuration might be obtained by focusing on relict channel features (partially filled sloughs and oxbows) rather than arbitrarily rectangular fenced plots.

CONTEXTUAL ANALYSES

These have been de-emphasized and delayed to focus on the other objectives. Ultimate activities might involve analysis of historic channel migration rates, longitudinal sampling of multiple drainages, historic air photo analyses, and hydraulic-fluvial geomorphic studies and modeling. In 2005, we will evaluate the feasibility and availability of different lines of evidence that might support a quantitative assessment of channel incision. Channel incision, if it has occurred, would be a parsimonious explanation of why willow communities along the Illinois River are not naturally meeting management goals.

CUMULATIVE DELIVERABLES

Auble, G.T., M.L. Scott, J. Roelle, and M. Laubhan. 2003. 2003 progress report on riparian willow restoration along the Illinois River at Arapaho NWR, Colorado. SSP03R603, unpublished. 9p.

Auble, G.T. 2004. Status of USGS-FWS willow restoration studies along the Illinois River. Technical briefing. Arapaho NWR, Walden, CO. September 7, 2004.

Auble, G.T., M.L. Scott, J. Roelle, and M. Laubhan. 2004. 2004 progress report on riparian willow restoration along the Illinois River at Arapaho NWR, Colorado. SSP03R603, unpublished. 5p.